AMENDMENTS TO THE CLAIMS

1. (Currently Amended) An optical device that connects, by a signal beam, between an externally inputted input signal and an output signal to be outputted, the optical device comprising:

~~an~~ a sheet-form optical transmission line ~~being sheet-form and including~~ having a refractive index distribution such that a highest refractive index part is provided in a direction of a thickness of the ~~sheet~~ optical transmission line and a refractive index does not increase with distance from the highest refractive index part in the direction of the thickness of the optical transmission line,

wherein a signal beam corresponding to the input signal is made incident on the optical transmission line as an incident beam,

wherein inside the optical transmission line, the incident beam is transmitted, in a direction of a length of the optical transmission line that is orthogonal to the direction of the thickness of the optical transmission line, in multiple modes having a plurality of eigenmodes in a direction of a width of the optical transmission line that is orthogonal to both the direction of the length of the optical transmission line and the direction of the thickness of the optical transmission line, and an exiting beam is generated by the plurality of eigenmodes interfering with each other in the direction of the length of the optical transmission line, ~~and~~

wherein the exiting beam is made to exit from the optical transmission line, and the output signal corresponding to the exiting beam is outputted,

wherein the optical transmission line has a refractive index distribution such that a

central position in the direction of the thickness of the optical transmission line has the highest refractive index and the refractive index does not increase with distance from the central position, and

wherein the optical transmission line is made of polysilane, and the refractive index distribution is provided by an oxygen concentration distribution when the polysilane is cured.

2. **(Currently Amended)** An optical device according to claim 1, wherein the optical transmission line has a size, in the direction of the length of the optical transmission line, expressed by a function of a difference between a propagation constant of a 0th-order mode excited in the direction of the width of the optical transmission line and a propagation constant of a primary mode.

3. **(Currently Amended)** An optical device according to claim 1, wherein the optical transmission line has a size, in the direction of the length of the optical transmission line, expressed by a function of a basic mode width in the direction of the width of the optical transmission line, the highest refractive index in the direction of the thickness of the optical transmission line, and a wavelength of a beam transmitted in the multi-mode optical transmission line.

4. **(Canceled)**

5. (Currently Amended) An optical device according to claim [[4]] 1, wherein the refractive index distribution changes substantially along a quadratic function.

6-7. (Canceled)

8. (Withdrawn) An optical device according to claim 1, wherein the input signal is an electric signal, and an incident portion is provided that converts the electric signal into the signal beam and makes the signal beam incident on the optical transmission line as the incident beam.

9. (Withdrawn) An optical device according to claim 8, wherein the incident portion has a plurality of light emitting portions disposed in an array in the direction of the width of the optical transmission line.

10. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the input signal is a signal beam, and an incident portion is provided that makes the signal beam incident on the optical transmission line as ~~an~~ the incident beam.

11. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the output signal is an electric signal, and an exit portion is provided that receives the signal beam as ~~an~~ the exiting beam having exited from the optical transmission line and

converts the signal beam into the electric signal.

12. (Withdrawn) An optical device according to claim 11, wherein the exit portion has a plurality of light receiving portions disposed in an array in the direction of the width of the optical transmission line.

13. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the output signal is a signal beam, and an exit portion is provided that makes the signal beam exit from the optical transmission line as ~~an~~ the exiting beam.

14. (Currently Amended) An optical device according to claim 1, wherein the optical device is a 1×N optical splitting device that is capable of receiving at least one input signal and outputting the input signal as a number, N (N=1,2,3,...), of output signals, and

wherein the optical transmission line includes:

an incident surface for making the incident beam incident; and

an exit surface for making the exiting beam exit,

the size in the direction of the length of the optical transmission line is a value that is substantially an integral multiple of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line

is λ, and

one incident beam is made incident on a center in the direction of the width <u>of the optical transmission line</u> on the incident surface and a number, N, of exiting beams are generated symmetrically with respect to the center in the direction of the width <u>of the optical transmission line</u> on the exit surface:

$$\frac{1}{N} \bullet \frac{n_0 W_0^2}{\lambda}$$

15. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical device is an N×1 optical combining device that is capable of receiving a number, N (N=1,2,3,...), of input signals and outputting the input signals as at least one output signal, and

wherein the optical transmission line includes:

an incident surface for making the incident beam incident;[[,]] and

an exit surface for making the exiting beam exit,

the size in the direction of the length <u>of the optical transmission line</u> is a value that is substantially an integral multiple of the following expression when the basic mode width in the direction of the width <u>of the optical transmission line</u> is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width <u>of the optical transmission line</u> is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ, and

a number, N, of incident beams all having the same wavelength λ are made incident

symmetrically with respect to a center in the direction of the width of the optical transmission line on the incident surface and one exiting beam is generated at the center in the direction of the width of the optical transmission line on the exit surface:

$$\frac{1}{N} \bullet \frac{n_0 W_0^2}{\lambda}$$

16. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical device is a straight sheet bus that is capable of receiving a number, N (N=1,2,3,...), of input signals and outputting the input signals as a number, N, of output signals corresponding one-to-one to the input signals, and

wherein the optical transmission line includes:

an incident surface for making the incident beam incident; and

an exit surface for making the exiting beam exit,

the size in the direction of the length of the optical transmission line is a value that is substantially an integral multiple of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ, and

a number, N, of incident beams all having the same wavelength λ are made incident on given positions in the direction of the width of the optical transmission line on the incident surface and a number, N, of exiting beams corresponding one-to-one to the number, N, of

incident beams are generated in positions, on the exit surface, whose positions in the direction of the width of the optical transmission line are the same as incident positions of the incident beams:

$$\frac{8n_0W_0^2}{\lambda}$$

17. **(Withdrawn - Currently Amended)** An optical device according to claim 1, wherein the optical device is a cross sheet bus that is capable of receiving a number, N (N=1,2,3,...), of input signals and outputting the input signals as a number, N, of output signals corresponding one-to-one to the input signals, and

wherein the optical transmission line includes:

an incident surface for making the incident beam incident; and

an exit surface for making the exiting beam exit,

a size in the direction of the length of the optical transmission line is a value that is substantially an odd multiple of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ, and

a number, N, of incident beams all having the same wavelength λ are made incident on given positions in the direction of the width of the optical transmission line on the incident surface and a number, N, of exiting beams corresponding one-to-one to the number, N, of

incident beams are generated in positions, on the exit surface, whose positions in the direction of the width of the optical transmission line are symmetrical to incident positions of the incident beams with respect to the center in the direction of the width of the optical transmission line:

$$\frac{4n_0W_0^2}{\lambda}$$

18. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical device is a star coupler that receives a number, N (N=1,2,3,...), of input signals and outputs the input signals as a number, N, of output signals corresponding to the input signals, and

wherein the optical transmission line includes:

an incident surface for making the incident beam incident; and

an exit surface for making the exiting beam exit,

a size in the direction of the length of the optical transmission line is substantially a value of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ, and

a number, N, of incident beams all having the same wavelength λ are made incident on predetermined positions in the direction of the width of the optical transmission line on the incident surface and a number, N, of exiting beams are generated for any one of the incident

beams in positions, on the exit surface, whose positions in the direction of the width of the optical transmission line are symmetrical to incident positions of the incident beams with respect to the center in the direction of the width of the optical transmission line:

$\left(p \pm \frac{1}{N}\right)\frac{4n_0W_0^2}{\lambda}$, wherein p is ~~(p is~~ an integer that makes the value inside the parentheses ~~positive)~~ positive.

19. (Withdrawn - Currently Amended) An optical device according to claim 18, wherein the optical device is a star coupler that receives a number, N_{EVEN} (N_{EVEN}=2,4,6,...), of input signals and outputs the input signals as a number, N_{EVEN}, of output signals corresponding to the input signals, and

wherein the optical transmission line makes a number, N_{EVEN}, of incident beams all having the same wavelength λ incident on positions symmetrical with respect to the center in the direction of the width of the optical transmission line on the incident surface.

20. (Withdrawn - Currently Amended) An optical device according to claim 18, wherein the optical device is a star coupler that receives a number, N_{ODD} (N_{ODD}=1,3,5,...), of input signals and outputs the input signals as a number, N_{ODD}, of output signals corresponding to the input signals, and

wherein the optical transmission line makes a number, N_{ODD}, of incident beams all having the same wavelength λ incident on positions asymmetrical with respect to the center in the direction of the width of the optical transmission line on the incident surface.

21. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical device is a two-way straight sheet bus that is capable of receiving a number, N (N=1,2,3,...), of input signals and outputting the input signals as a number, N, of output signals corresponding one-to-one to the first input signals, and is capable of receiving a number, M (M=1,2,3,...), of input signals and outputting the input signals as a number, M, of output signals corresponding one-to-one to the input signals, and

wherein the optical transmission line includes:

a first surface formed at one end in the direction of the length of the optical transmission line; and

a second surface formed at another end in the direction of the length of the optical transmission line,

a size in the direction of the length of the optical transmission line is a value that is substantially an integral multiple of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ,

a number, N, of incident beams all having the same wavelength λ are made incident on given positions in the direction of the width of the optical transmission line on the first surface and a number, N, of exiting beams corresponding one-to-one to the number, N, of incident beams are generated in positions, on the second surface, whose positions in the direction of

the width of the optical transmission line are the same as incident positions of the incident beams, and

a number, M, of incident beams all having the same wavelength λ as the incident beams on the first surface are made incident on given positions in the direction of the width of the optical transmission line on the second surface and a number, M, of exiting beams corresponding one-to-one to the number, M, of incident beams are generated in positions, on the first surface, whose positions in the direction of the width of the optical transmission line are the same as incident positions of the incident beams:

$$\frac{8n_0W_0^2}{\lambda}$$

22. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical device is a two-way cross sheet bus that is capable of receiving a number, N (N=1,2,3,...), of first input signals and outputting the input signals as a number, N, of first output signals corresponding one-to-one to the first input signals, and is capable of receiving a number, M (M=1,2,3,...), of second input signals and outputting the input signals as a number, M, of output signals corresponding one-to-one to the second input signals, and

wherein the optical transmission line includes:

a first surface formed at one end in the direction of the length of the optical transmission line; and

a second surface formed at another end in the direction of the length of the optical transmission line,

a size in the direction of the length of the optical transmission line is a value that is substantially an odd multiple of the following expression when the basic mode width in the direction of the width of the optical transmission line is W_0, an effective refractive index of a 0th-order mode beam excited in the direction of the width of the optical transmission line is n_0 and the wavelength of the beam transmitted in the multi-mode optical transmission line is λ,

a number, N, of incident beams all having the same wavelength λ are made incident on given positions in the direction of the width of the optical transmission line on the first surface and a number, N, of exiting beams corresponding one-to-one to the number, N, of incident beams are generated in positions, on the second surface, whose positions in the direction of the width of the optical transmission line are symmetrical to incident positions of the incident beams with respect to the center in the direction of the width of the optical transmission line, and

a number, M, of incident beams all having the same wavelength λ are made incident on given positions in the direction of the width of the optical transmission line on the second surface and a number, M, of exiting beams corresponding one-to-one to the number, M, of incident beams are generated in positions, on the first surface, whose positions in the direction of the width of the optical transmission line are symmetrical to incident positions of the incident beams with respect to the center in the direction of the width of the optical transmission line:

$$\frac{4n_0W_0^2}{\lambda}$$

23. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical transmission line includes: a reflecting surface that is formed at one end in the direction of the length <u>of the optical transmission line</u> and bends an optical path of the incident beam incident in a direction parallel to the direction of the thickness <u>of the optical transmission line</u>, substantially 90 degrees in the direction of the length <u>of the optical transmission line</u>; and/or a reflecting surface that is formed at another end in the direction of the length <u>of the optical transmission line</u> and bends an optical path of the exiting beam transmitted in the direction of the length <u>of the optical transmission line</u>, substantially 90 degrees so as to exit in a direction parallel to the direction of the thickness <u>of the optical transmission line</u>.

24. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical transmission line includes: a prism that is formed at one end in the direction of the length <u>of the optical transmission line</u> and bends, in the direction of the length <u>of the optical transmission line</u>, an optical path of the incident beam incident in a direction inclined in the direction of the thickness <u>of the optical transmission line</u>; and/or a prism that is formed at another end in the direction of the length <u>of the optical transmission line</u> and bends an optical path of the exiting beam transmitted in the direction of the length <u>of the optical transmission line</u>, so as to exit in a direction inclined in the direction of the thickness <u>of the optical transmission line</u>.

25. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical transmission line has a plurality of eigenmodes in the direction of the thickness of the optical transmission line.

26. (Withdrawn) An optical device according to claim 1, wherein the optical transmission line has a thickness of not less than 20 μm.

27. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical transmission line is curved so that a central position in the direction of the thickness of the optical transmission line always draws the same curve on given two different cross sections including the direction of the length of the optical transmission line and the direction of the thickness of the optical transmission line.

28. (Withdrawn - Currently Amended) An optical device according to claim 1, wherein the optical transmission line is twisted so that a central position in the direction of the thickness of the optical transmission line draws different curves on given two different cross sections including the direction of the length of the optical transmission line and the direction of the thickness of the optical transmission line.

29. (Canceled)

30. (Withdrawn - Currently Amended) A method of manufacturing an optical device that connects, by a signal beam, between an externally inputted input signal and an output signal to be outputted,

wherein the optical device comprises

~~an~~ a sheet-form optical transmission line ~~being sheet-form and including~~ having a refractive index distribution such that a highest refractive index part is provided in a direction of a thickness of the ~~sheet~~ optical transmission line and a refractive index does not increase with distance from the highest refractive index part in the direction of the thickness of the optical transmission line,

wherein a signal beam corresponding to the input signal is made incident on the optical transmission line as an incident beam,

wherein inside the optical transmission line, the incident beam is transmitted, in a direction of a length of the optical transmission line that is orthogonal to the direction of the thickness of the optical transmission line, in multiple modes having a plurality of eigenmodes in a direction of a width of the optical transmission line that is orthogonal to both the direction of the length of the optical transmission line and the direction of the thickness of the optical transmission line, and an exiting beam is generated by the plurality of eigenmodes interfering with each other in the direction of the length of the optical transmission line,

wherein the exiting beam is made to exit from the optical transmission line, and the output signal corresponding to the exiting beam is outputted,

wherein the optical transmission line has a refractive index distribution such that a

central position in the direction of the thickness of the optical transmission line has the highest refractive index and the refractive index does not increase with distance from the central position,

wherein the optical transmission line is made of polysilane, and the refractive index distribution is provided by an oxygen concentration distribution when the polysilane is cured, and

wherein the optical device manufacturing method comprises:

a first step of preparing a forming die that is made of a material capable of transmitting an energy to be applied to cure a resin of which the optical transmission line is made, and includes a concave portion having at least the same depth as the direction of the thickness of the optical transmission line;

a second step of filling the concave portion with the resin;

a third step of applying the energy in a predetermined quantity to the forming die filled with the resin, from above and below in the direction of the thickness of the optical transmission line; and

a fourth step of, on the resin cured with a desired refractive index distribution being formed, determining at least a size in the direction of the length of the optical transmission line and forming a part of connection of the incident and exiting beams in order to form the resin into the optical transmission line.

31. (Withdrawn) An optical device manufacturing method according to claim 30,

wherein in the third step,

the application of the energy is an application of an ultraviolet ray of a predetermined wavelength, and

wherein in the first step,

the prepared forming die is made of a material that is transparent with respect to the ultraviolet ray of the predetermined wavelength.

32. (Withdrawn) An optical device manufacturing method according to claim 30, wherein in the third step,

the application of the energy is heating.

33. (Canceled)

34. (Withdrawn - Currently Amended) An optical device manufacturing method according to claim ~~33~~ 30, wherein the refractive index distribution changes substantially along a quadratic function.

35-36. (Canceled)

37. (Withdrawn - Currently Amended) An optical device manufacturing method according to claim 30, wherein in the first step,

the forming die includes a concave portion having a size including a plurality of optical transmission lines to be manufactured, and

wherein in the fourth step,

a plurality of optical transmission lines [[is]] are simultaneously manufactured by cutting the resin.

38. (Withdrawn - Currently Amended) An optical device manufacturing method according to claim 30, wherein in the first step,

the forming die includes a concave portion having a size substantially equal to a size, in the direction of the width of the optical transmission line, of the optical transmission line to be manufactured, and

wherein in the fourth step,

the size in the direction of the length of the optical transmission line is determined by cutting the resin.

39. (Withdrawn - Currently Amended) An optical device manufacturing method according to claim 30, wherein in the first step,

the forming die includes a concave portion having a size substantially equal to a size of the optical transmission line to be manufactured, and

wherein in the fourth step,

a wall, of the concave portion, situated in a position where the incident beam and the

exiting beam are made incident and made to exit on and from the optical transmission line is removed.

40. (Withdrawn) An optical device manufacturing method according to claim 30, further comprising a fifth step of releasing the optical transmission line from the forming die either before or after the fourth step.

41-123. (Canceled)